Review of European Studies; Vol. 7, No. 3; 2015
ISSN 1918-7173 E-ISSN 1918-7181
Published by Canadian Center of Science and Education

Are Universities in Taiwan Less Efficient than Top Universities in the World?

Hsuan-Fu Ho[1]

[1] Graduate Institute of Educational Administration and Policy Development, National Chiayi University, Taiwan

Correspondence: Hsuan-Fu Ho, Graduate Institute of Educational Administration and Policy Development, National Chiayi University, Taiwan. Tel: 886-9-2291-0101. E-mail: hfho@mail.ncyu.edu.tw

Received: December 15, 2014 Accepted: January 21, 2015 Online Published: February 19, 2015

doi:10.5539/res.v7n3p202 URL: http://dx.doi.org/10.5539/res.v7n3p202

Abstract

The world has put an increasing emphasis on the university ranking system in the last decade. However, only one university in Taiwan has once dashed into the top 100 league of the world ranking system. The Taiwan Government has blamed the higher educational institutions in Taiwan for less efficient, while many scholars attribute the major cause to the insufficient investment in the higher educational system. This research thus endeavored to compare the efficiency among universities in Taiwan and those in the world. DEA and AHP were adopted as main research methods. The research results indicated that Taiwan universities were efficient when comparing with their world counterparts.

Keywords: efficiency, DEA, AHP, university, higher education

1. Introduction

The globalization and knowledge economy has forced governments in the world to put special importance on improving the quality of their higher educational systems (Vughta & Westerheijden, 2010). However, running a sound higher educational system costs a great deal, and since most governments cannot afford the steadily increasing running costs, they turned to demand universities to enhance the efficiency of their resources allocation. As a result, the higher educational evaluation system, the transparency of resource allocation activities, and a variety of university ranking systems initiated in recent years are all emphasizing especially on the operational efficiency of resource management (Marginson, 2007; Taylor & Braddock, 2007; Liu & Rosa, 2008). Taiwan is no exception. Although the university evaluation system in Taiwan occurred many years behind the more advanced countries, the "Fifty Billion in Five Years" university granting plan newly initiated by the Taiwan government revealed the great ambition for enhancing the quality of universities. Accompanied with this university granting plan is the mandate for improving the operational efficiency of resource allocation.

Many scholars, however, bemoaned that the university evaluation systems in many countries focus only on the "output" part, while ignoring the "input" part (Dill & Soo, 2005; Federkeil, 2008), and they further suggest that the evaluation without considering the cost part is not fair and is irrational because some inefficient universities that invest many times more resources than others while achieve only a little better were valued in higher levels on the ranking league.

Some scholars further stress that an understanding of input efficiency and output efficiency far from enough, because in the real life, inputs and outputs are interact with each other through the "process" activities, for this reason, ignoring the process efficiency is futile (Glass, McKillop, & Hyndman, 1995). However, although there is ample literature in university efficiency, almost all of the literature failed to discuss the "process" efficiency, and it is important, therefore, to stress more on the process part. Another problem in evaluating the efficiency of the university lies on what elements should be included in the analyses. More than often, scholars only use single element to measure efficiency, and this is absurd because in the real life, the quality of a university is composed of many different parts, hence, determining the adequate elements for evaluation should be the prerequisite for a successful and practical research (Glass, McKillop, & Hyndman, 1995).

Data Envelopment Analysis (DEA) invented by Charnes, Cooper, and Rhodes in 1978 is a widely used method for measuring efficiency. It is used to measure productive efficiency of decision making units (DMU) by the estimations of production frontiers. Since it has a variety of applications, it has become an increasingly popular

management tool (Salerno, 2006). Therefore, we decided to adopt DEA as one of the major calculation method to evaluate the operational efficiency among universities in Taiwan and those in the world.

As mentioned previously, the Taiwan Government has initiated a variety of policies to enhance the quality of higher education, expecting that some of the universities in Taiwan will be valued as one of the top 100 universities in the world ranking league. However, in the past few years, only National Taiwan University joined the top 100 club in The London Times World University Ranking in 2010. The Taiwanese government apparently did not satisfied with this result, and has thus mandated all universities to better use their resources for quality enhancement. Universities in Taiwan certainly are facing tremendous pressure in squeezing into the top 100 club.

Some scholars, however, suggested that universities in Taiwan are already efficient, and the reason for failing to be involved in the top 100 league simply because there are not enough resources allocated to universities in Taiwan. In other words, if universities in Taiwan were provided with the same amount of resources as their world counterparts, they will have equal or even better achievements than the top universities in the world. This research is thus aimed to examine the operational efficiency of Universities in Taiwan in comparing with those in the world.

2. Literature Review

2.1 The Concept of Efficiency

Shi and Wang (2004) suggest that efficiency generally describes a favorable ratio of benefit and cost. Nagel (1986) argues that efficiency can be defined as one of the following concept, and which one should be select as the best option is merely depending on the unique objectives pursued. Efficiency should be defined as to:

- Maximize the benefits;
- Minimize the costs;
- Minimize the costs with minimum benefits;
- Maximize the costs with maximum benefits;
- Maximize the benefit cost ratio;
- Minimize the cost benefit ratio;
- Maximize the residual of benefit minus cost;
- Maximize the quotient of the residual of benefit minus cost then divided by the cost;
- Maximize the benefit change divided by cost change;
- Maximize the benefit change ratio divided by cost change ratio.

Boardman, Greenberg, Vining, and Weimer (1996) suggest that although efficiency in general is to reduce the cost or to enlarge the benefit, enlarging the benefits is preferable only when the effectiveness will not be diminished. In other words, in public administration, effectiveness often is more important than efficiency. Moore (1995) proposes a similar explanation, and he stresses that in public administration, effectiveness is more important than efficiency, and therefore efficiency should be defined as reducing the cost/benefit ratio while ensuring that effectiveness is unchanged or enlarged.

Avikeran (2001) views efficiency from the perspective of economics, and he suggest that the best way to measure efficiency is Pareto optimality, which means the allocation of resources or a state of affairs in which it is unattainable to make any one individual better off without causing at least one individual worse off. He further argues that in social science, anything unequal to Pareto Optimal is inefficient.

2.2 Efficiency of Universities

Hubbell (2007) recommends that the efficiency of higher education is difficult to measure because there are many customers of a university, and faculty, staff, student, parent, government, community are all main stakeholders of the university, and since different stakeholders vary a great deal in what they want, a consensus of effectiveness or efficiency is very difficult, if not impossible, to achieve.

Concerning the efficiency of the universities, Montesinos, Carot, Martinez and Mora (2008) argue that the first university was established in medieval times in Europe, and the most important missions of universities were teaching and research. Therefore, the teaching and research should be viewed as the two major criteria for measuring efficiency. Taylor and Braddock (2007), however, dispute that the mission of the university system has been expanded many times since its appearance in medieval times. Now-a-days, publications, teacher student

ratio, class size, annual expenditures, curriculum satisfaction, and graduates' competences are all good criteria for measuring university efficiency.

Federkeil (2008) suggest that the university ranking systems are good resources for understanding what are the most important elements or missions of a good university, and the criteria most used by ranking systems are the most essential ones for efficiency measure. Usher and Savino (2007) also point out that although there are differences in criteria used in different ranking systems, the ranking results are very similar, and this is especially true among the advanced universities.

Kaneko (1997) and Abbott and Doucouliagos (2003) propose that ensuring university graduates are possessing adequate competence demanded by the work place is essential in today's society, and therefore, the measuring of university efficiency by using economic indicators such as rate of return or internal rate of return are more reasonable. Moreover, Johnes and Johenes (1995), Joumady and Ris (2005), and Ruggiero (2007) all point out that the technique of Data Envelopment Analysis is measuring the efficiency frontier by using multiple inputs and outputs from an economics perspective, it is a practical method for efficiency measuring among universities.

3. Research Design

3.1 Calculation Methods

In this research, we mainly use data envelopment analysis (DEA) to measure operational efficiency of DMUs (decision making unit). Data envelopment analysis is a linear programming based technique for evaluating the relative operational performance of institutions where the presence of multiple inputs and outputs makes comparison difficult. The DMUs with an efficiency of 1 (100%) from a mathematical space often called efficient frontier, which envelops all the other DMU points in the visual map, the distance to the efficient frontier is the degree of in efficiency or the space for improvement, and therefore, DEA also provides improvement guidelines for the inefficient DMU.

Following is the DEA calculation function, where N=number of DMU, m=number of input elements, n=number of output elements. Suppose k is one of the participating universities, then E_k is the efficiency of the kth DMU, and Y_{rk} (r=1 … n) is the output amount, and X_{ik} (i=1 … m).

$$\text{Maximize, } E_k=\frac{\sum_{r=1}^{n} U_r Y_{rk}}{\sum_{i=1}^{m} V_i X_{ik}}$$

$$\text{Subject to } \frac{\sum_{r=1}^{n} U_r Y_{rj}}{\sum_{i=1}^{m} V_i X_{ij}} <=1,\ j=1,\ \dots,\ N.$$

However, DEA also has some shortcomings, and one of them is that the weight of elements are not known in advance in DEA calculations, rather, the weights are occurring in the calculation process, where the weights for each institution (DMU) are calculated as the most favorable weight for that particular institution. Therefore, in this research, we decided to use analytic hierarchy process (AHP) to calculate the weights for each university.

AHP is a way of decomposing a complex problem and reconstruct it into an organized decision hierarchy. By breaking down a big problem into smaller ones, AHP allows us to clarify the relationships between each sub-elements of the whole research structure. We select AHP as one of the major calculating methods because AHP is decent for collecting opinions from experts, allocating weights to individual elements, and accurately calculate the weights of each element (Saaty, 1980; Cheng, Li, & Ho, 2002). The calculating function is as follows:

$$A=[a_{ij}]\begin{bmatrix} 1 & a_{12} & \cdots & a_{1m} \\ a_{21} & 1 & & a_{2m} \\ \vdots & & \ddots & \vdots \\ a_{m1} & a_{m2} & \cdots & 1 \end{bmatrix}$$

$$\begin{bmatrix} 1 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & 1 & & w_2/w_n \\ \vdots & & \ddots & \vdots \\ w_n/w_2 & w_n/w_2 & \cdots & 1 \end{bmatrix}$$

$$Wi= 1/m \sum_{j=1}^{m} a_{ij} \Big/ \sum_{j=1}^{m} aij$$

Finally, λ_{max} was used to calculate the reliability of the dat. If CR $\leq$ 0.1 means the data is adequate and reliable

$$A\times K = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1m} \\ a_{21} & 1 & & a_{2m} \\ \vdots & & \ddots & \vdots \\ a_{m1} & a_{m2} & \cdots & 1 \end{bmatrix} \times \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_m \end{bmatrix} = \begin{bmatrix} w'_1 \\ w'_2 \\ \vdots \\ w'_m \end{bmatrix}$$

$$\lambda_{max} = (1/m) \times \left(\frac{w'_1}{w_1} + \frac{w'_2}{w_2} + \cdots + \frac{w'_m}{w_m}\right)$$

$$CI = \frac{\lambda max - m}{m-1}$$

$$CR = \frac{CI}{RI}$$

3.2 Criteria for Analysis

The first step of conducting a data envelopment analysis is to identify the elements contributing to the quality of university and should thus be considered. In this research we use faculty numbers, administrative staff numbers, school assets, and school annual expenditure as the input elements; Undergraduate student number, graduate student number, journal publications, and research grants as the output elements.

3.3 Sampling and Data Collection

There are several criteria for university selection. In order to examine whether the shortage of resources is one of the major reasons contributing to Taiwanese universities' failing to jostle into in the top 100 universities of the world ranking systems, we decided to select participant universities from the top 100 league in the Times World University Ranking. Moreover, since we needed input information to conduct DEA analysis, we selected only universities posted their input information in school website. All the information used in this research was collected from the website of the selected universities.

A total of 14 universities were selected in this research, including a university from Taiwan. In order to ensure that universities will not be recognized, we decided to use pseudonyms for each university by revealing only its geographic location. University A is one of the top 5 universities in Taiwan; University B, University C, University D, University E, University F, and University G are universities in America; University H, University I, and University J are universities in Europe; Finally, University K, University L, University M, and University N are locating in Asia. All of the above universities are included in the top 100 ranking in Times World University Ranking in 2010.

4. Research Results

4.1 Teaching Efficiency

When we focus on the university teaching efficiency, we found that University is efficient. University B, University C, University D, and University E, University L, and University N are also efficient. It is also interesting to find that all universities in Europe are comparatively less efficient in teaching (as defined by under graduate student numbers and graduate student numbers), which means they might use more resources while teaching less students.

Table 1. Teaching efficiency

University	Area	Efficiency
University A	America	100%
University B	America	100%
University C	America	100%
University D	America	100%
University E	America	100%
University F	America	66.9%
University G	America	63.0%

University H	Europe	42.6%
University I	Europe	54.9%
University J	Europe	69.2%
University K	Asia	29.2%
University L	Asia	100%
University M	Asia	94.9%
University N	Asia	100%

4.2 Research Efficiency

In this part, we examined the efficiency of research among universities. However, only eight selected universities published their research information in their website, and therefore, we used only these eight universities for DEA analysis. The research results showed that only University K was not efficient, and all the other universities were efficient.

Table 2. Research efficiency

University	Area	Efficiency
University A	America	100%
University B	America	100%
University C	America	100%
University F	America	100%
University H	Europe	100%
University I	Europe	100%
University K	Asia	61.8%
University N	Asia	100%

4.3 AHP Results

As mentioned previously, DEA cannot decide the weight in Advance. However, the elements used in the DEA analysis might have very different importance for or contributions to operational efficiency. Therefore, we decided to adopt AHP as a method to calculate the relative weights of each element. The results indicated that publication and research grants gained were the most important output elements, while annual expenditure is the most important input element.

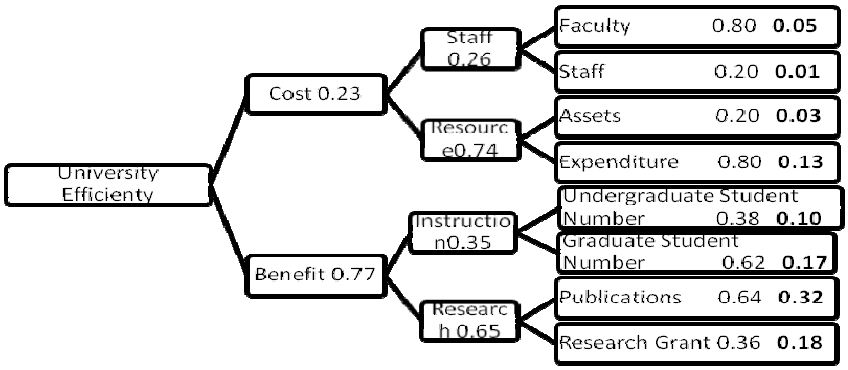

Figure 1. Weight of elements

4.4 Weighted Teaching Efficiency

We then used the weights of each element produced by AHP to weight the data, and then use the weighted data for another DEA efficiency examination. Again, the results showed that University A is efficient. However, some of the universities in Europe were efficient now, which means universities in Europe were stronger in gaining research grants and publications than in teaching more students than the other countries.

Table 3. Weighted teaching efficiency

University	Area	Efficiency
University A	Taiwan	100%
University B	America	100%
University C	America	100%
University D	America	100%
University E	America	100%
University F	America	100%
University G	America	57.0%
University H	Europe	65.4%
University I	Europe	53.2%
University J	Europe	100%
University K	Asia	84.8%
University L	Asia	100%
University M	Asia	100%
University N	Asia	100%

4.5 Weighted Research Efficiency

Once again, we use the weighted data set to calculate the efficiency of research quality, and the results showed that University A is efficient. University K in Asia needed serious improvement in research efficiency.

Table 4. Weighted research efficiency

University	Area	Efficiency
University A	Taiwan	100%
University B	America	100%
University C	America	100%
University F	America	87.4%
University H	Europe	100%
University I	Europe	100%
University K	Asia	40.1%
University N	Asia	100%

5. Conclusions

The world has put a heavy emphasis on the university ranking systems recently. However, the ranking system often reveals only the outputs of the universities without considering the input elements. Only one university in Taiwan has ever ranked as the top 100 in the ranking league. Government in Taiwan thus blamed universities for not efficient, while scholars in Taiwan pointed out that the failure is not caused by less efficiency, but the lack of resources available to enhance the quality. This research is thus aimed to examine the reasons for Taiwanese

Universities' malfunction in the world ranking contests.

The research results showed that University A (one of the top 5 university in Taiwan that was selected as a participant in the research) was efficient in teaching efficiency, research efficiency, weighted teaching efficiency, and weighted research efficiency, which indicated that universities in Taiwan are efficient, and if provide Taiwanese universities sufficient amount of resources, then universities in Taiwan might resulted in the same or even better achievements than their top 100 counterpart universities in the world. And we thus suggest that if the government really want to enhance the results of Taiwan universities in the world ranking system, then it is important to ensure that universities in Taiwan receiving similar resources to their competitors.

All of the European universities that selected from the top 100 universities in the Times World University Ranking were valued in this research as inefficient in teaching (defined as serving maximum number of undergraduate students and graduate students). This result indicated that quality and efficiency not go hand in hand all the time, and more than often, they contradict with each other. European universities might wish to ensure the educational quality by reducing the student/teacher ratio while sacrificing the economic efficiency.

The AHP results showed that scholars in Taiwan perceived publication as the most important input element in evaluating university efficiency, followed by research grants, number of graduate students, and number of undergraduate students. Moreover, annual expenditure was valued as the most important input element, followed by faculty number, school assets, and administrative staff number.

Finally, due to the difficulty in information collection, we used only 8 elements (4 input elements and 4 output elements) and 14 universities for DEA calculation, and we suggest that future studies may expand the participant pool as well as broaden the size of elements in DEA calculations.

Reference

Abbott, M., & Doucouliagos, C. (2003). The efficiency of Australian universities: A data envelopment analysis. *Economics of Education Review*, *22*(1), 89-97. http://dx.doi.org/10.1016/S0272-7757(01)00068-1

Boardman, A. E., Greenberg, D. H., Vining, D. L., & Weimer, D. L. (1996). *Cost-benefit analysis: Concepts and practice*. Upper Saddle River, NJ: Prentice Hall.

Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision-making units. *European Journal of Operational Research*, *2*(6), 429-444. http://dx.doi.org/10.1016/0377-2217(78)90138-8

Dill, D. & Soo, M. (2005). Academic quality, league tables, and public policy: A cross national analysis of university ranking systems. *Higher Education*, *49*(4), 495-533. http://dx.doi.org/10.1007/s10734-004-1746-8

Federkeil, G. (2008). Ranking and quality assurance in higher education. *Higher Education in Europe*, *33*(2-3), 219-231. http://dx.doi.org/10.1080/03797720802254023

Glass, J. C., McKillop, D. G., & Hyndman, N. (1995). Efficiency in the provision of university teaching and research: An empirical analysis of UK universities. *Journal of Applied Econometrics*, *10*(1), 61-72. http://dx.doi.org/10.1002/jae.3950100106

Hubbell, L. L. (2007). Quality, efficiency, and accountability: Definitions and applications. *New Directions for Higher Education*, *140*, 5-13. http://dx.doi.org/10.1002/he.276

Johnes, J., & Johnes, G. (1995). Research funding and performance in U.K. university departments of economics: A frontier analysis. *Economics of Education Review*, *14*(3), 301-314. http://dx.doi.org/10.1016/0272-7757(95)00008-8

Joumady, O., & Ris, C. (2005). Performance in European Higher Education: A non-parametric production frontier approach. *Education Economics*, *13*(2), 189-205. http://dx.doi.org/10.1080/09645290500031215

Kaneko, M. (1997). Efficiency and equity in Japanese higher education. *Higher Education*, *34*, 165-181. http://dx.doi.org/10.1023/A:1003005519014

Liu, C. C., & Chang, C. Y. (2004). A two-dimensional model for allocating resources to R&D programs. *The Journal of American Academy of Business*, *5*(1-2), 469-473.

Marginson, S. (2007). Global university rankings: Implications in general and for Australia. *Journal of Higher Education Policy and Management*, *29*(2), 131-142. http://dx.doi.org/10.1080/13600800701351660

Montesinos, P., Carot, J. M., Martinez, J., & Mora, F. (2008). Third mission ranking for world class universities: Beyond teaching and research. *Higher Education in Europe*, *33*(2-3), 259-271.

http://dx.doi.org/10.1080/03797720802254072

Moore, S. T. (1995). Efficiency in social work practice and administration. *Social Work*, *40*(5), 602-608.

Nagel, S. S. (1986). Efficiency, effectiveness, and equity in public policy evaluation. *Policy Studies Review*, *6*(1), 99-120. http://dx.doi.org/10.1111/j.1541-1338.1986.tb00651.x

Ruggiero, J. (2007). Measuring the cost of meeting minimum educational standards: An application of data envelopment analysis. *Education Economics*, *15*(1), 1-13. http://dx.doi.org/10.1080/09645290601133845

Salerno, C. (2006). Using data envelopment analysis to improve estimates of higher education institution's per-student education costs. *Education Economics*, *14*(3), 281-295. http://dx.doi.org/10.1080/09645290600777485

Shi, Q., & Wang, D. (2004). Credit: A new perspective for solving the contradiction between equity and efficiency in higher education. *Chinese Education and Society*, *37*(1), 72-88.

Taylor, K. P., & Braddock, R. (2007). International university ranking systems and the idea of university excellence. *Journal of higher education policy and management*, *29*(3), 245-260. http://dx.doi.org/10.1080/13600800701457855

Usher, A., & Savino, M. (2007). A global survey of university ranking and league tables. *Higher Education in Europe*, *32*(1), 5-15. http://dx.doi.org/10.1080/03797720701618831

Van Vught, F. A., & Westerheijden, D. F. (2010). Multidimensional ranking: A new transparency tool for higher education and research. *Higher Education Management and Policy*, *22*(3), 31-56. http://dx.doi.org/10.1787/hemp-22-5km32wkjhf24